SUMMARY OF OFFICE OF RIVER PROTECTION (ORP) EVALUATION OF BECHTEL NATIONAL, INC. (BNI) LOW ACTIVITY WASTE (LAW) BASEMAT COLD JOINT ENGINEERING REPORT

1. **ORP Comment**: Section 6 - Conclusions of the report are not consistent with the Executive Summary. They present two different Root Causes for the Cold Joint.

BNI Response: Section 6 and the Executive Summary will be modified in the final revision of the report. They will be changed to be consistent with what has already been presented to the DNFSB. Both sections will include the following as the Root Cause:

> "The Root Cause Evaluation identified that BNI accepted Sub-Contractor's Batch Plant without knowing its limitations, specifically its inability to produce 70^{o}F concrete at ambient temperatures exceeding 95^{o}F. "

ORP Evaluation: The response is acceptable. BNI indicated that it will revise the report to incorporate the ORP comments by January 10, 2003.

2. **ORP Comment**: DOE inspectors have questioned why the rebar directly underneath the wall sections does not have to be exposed completely, as is required in the areas of the cold joint away from the walls.

BNI Response: Review of existing calculations for the LAW building basemat (24590-LAW-DBC-S13T-00009, Rev. 2) show that no tensile stresses under the walls due to thermal loading are present. Bending movement under the walls is also low due to the stiffening effect of the walls above. The calculations show the top mat reinforcing directly under the interior walls has a maximum D/C (design/capacity) ratio of 0.46 in the area of the cold joint.

Although there is no visual indication, it can be assumed that there is degradation of the bond of these partially exposed bars. This degradation could be likened to the similar reduction in bond due to epoxy coating rebar, 20% reduction per ACI 318 12.2.4. As shown above, we are less than 50% stressed in these areas.

BNI Engineering Mark Scott performed a walk-down of the area, and as shown by the attached pictures, the rebar that is partially exposed is bounded by additional bars. The additional confinement provided by both the vertical dowel rebars and the horizontal mat rebars will preclude any splitting stresses that would reduce development capacity.

ORP Evaluation: BNI reviewed the structural calculations and performed a walkdown to identify the rebar exposed directly underneath the wall sections. BNI determined that the low demand/capacity ratio combined with additional rebars placed by construction was sufficient to assure structural integrity in the area underneath the wall sections. The response is acceptable.

3. **ORP Comment**: The engineering report (Section 4, 4th Paragraph, page 11) states that cold concrete will be heated to 60°F to obtain the best possible bond. Please clarify.

BNI Response: Providing a temperature of the existing concrete close to that of the temperature of the new concrete placement temperature will promote a better bond between the two surfaces. Note: We are not relying on this bond in our engineering analysis.

The Engineering report, Reference 8 from Gary Mass stated his suggestion and reason for the 60°F requirement of the concrete. It focused on enhancing the bonding of the new concrete. Our choice of using the heat is a conservative approach to complement the bond and provide an optimum condition. The purpose of the heat is to optimize the bonding of concrete placements, not to address restraint effects of a cold foundation or to reduce/control cracking.

The construction joints were chosen as the method to minimize the differential shrinking potential which could cause cracks. They are located to keep the majority of each smaller placement approximately the same depth.

ORP Evaluation: BNI has determined that the old concrete should be heated to 60°F to minimize differential shrinking potential and cracking. The ORP agrees with this construction plan.

4. **ORP Comment**: The engineering report (Section 5, 3rd Paragraph, page 12) states that aggregate size will be selected to ensure the desired workability and consolidation of the concrete. Normally the aggregate size is dictated by the dimensions of the section and the congestion of the embedded items. Please clarify in the report which concrete mixture is appropriate for which location.

BNI Response: The mixes used will be existing currently approved mixes. The project has 1-1/2", 3/4" and 3/8" mixes approved. We will be using primarily the F-5 mix (3/4" aggregate) for the cold joint placements. Under the turntables, we will likely use the F-3 / S-3 (3/8" aggregate) in order to alleviate the difficulty of placing concrete under the embed. F-4 mix (1 1/2" aggregate) is planned to be used in placement 1D, the furthest north and deepest placement. F-5 will be used on the surface as a topping course.

ORP Evaluation: The BNI response is acceptable.

5. **ORP Comment**: The engineering report (Executive Summary, 6th paragraph, page 2) does not identify what temperature the existing surface was at for placement of the dowels, the "soak time," if any, the method used to heat the surface, nor the depth of heating of the surface. Please clarify the purpose and method for heating the existing surface, as well as any measurements taken to assure an appropriate concrete surface temperature prior to new placement of concrete. Also, please describe whether it was necessary to control thermal differential between the middle of the concrete mass and the outside surface.

BNI Response: During the doweling operation the area was tented and heated, so as to maintain temperatures recommended by the grout manufacturer. Currently the dowels in 1B, which is the furthest south portion, have been placed. 1C, the middle portion has all the remaining dowels, which are scheduled to be grouted this week and next.

The concrete was under weather protection and was heated to provide at least 45^{o}F prior to grout placement for the 1B's dowels. The holes were under a 24-hour pre-soak period prior to the grout placement, in accordance with the Special Instruction. The heat was obtained by supplying heated air via a combination of two, and sometimes four 350,000 btu and 500,000 btu heaters. The ambient was much warmer than the concrete temperature; however, the temperature of the concrete met the manufacturer's instructions at placement.

Concerning control of thermal differential; this generally applies to concrete that is placed in excess of 36" (in the least dimension). This criterion is stipulated in Specification 24590-WTP-3PS-D000-T0001. These requirements are in effect for the final placement of concrete in the cold joint area.

ORP Evaluation: BNI provided an adequate process description of pre-heating and "soak time" prior to the placement of next concrete. BNI's control process of concrete temperatures for the placement of dowels and the new concrete is acceptable.

6. **ORP Comment:** Clarify the locations for data in the Results Column of Item No 3 of Table 2 of the Engineering Report. Also, explain why two effective placement temperatures were calculated, why is it is acceptable for one of these temperatures (79 F) to be greater than the 75 F maximum cited throughout the report, and what are the locations of the calculated peak internal temperatures.

BNI Response: Table 2 will be clarified by changing the Results box to the following:

> The calculated maximum thermal stress was 299 psi which is less than 474 psi. Therefore, no cracking will occur due to thermal volume change. (See Reference 8)

The temperatures that were listed in Item No 3 were net effective placement temperatures. Reference 8 lists the Net effective placement temperatures for the three areas identified by G. Mass. They are as follows:

> Area 1 = 74^{o}F
> Area 2 = 75^{o}F
> Area 3 = 79^{o}F. (continuously exposed to ambient conditions)

The 79^{o}F is the calculated value for Area 3. Area 3 is described in the reference as, "the cold joint in the center of the section which has an estimated thickness of 4.5 feet and was placed with 4 feet of concrete at, or below 70^{o}F and 0.5 feet of concrete above 70^{o}F. This area was left exposed and was cured with water". ACI 207.2R, Fig 2.6 was used to calculate the rise from the measured placement temperatures.

The 75^{o}value (area 2) created the maximum internal temperature and consequently the maximum thermal stress.

The Reference 8 also clarifies the location of the calculated internal temperatures:

Area 1 = 150^{o}F
Area 2 = 151^{o}F
Area 3 = 116^{o}F.

Area 3, as stated above, being the area that was not insulated and received an extended water cure.

ORP Evaluation: BNI clarified the information provided in the Table 2 of the engineering report. The BNI clarification to the soundness of concrete sections related to thermal consideration is acceptable.